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Request for grant of a patent

The Patent Office
Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference

5245401/JJG

2. Patent Application Number

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

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Patents ADP number *(if known)* 6791636002

If the applicant is a corporate body, give the country/state of its incorporation

Country: ENGLAND
State:

4. Title of the invention

LOCAL COMMUNICATION SYSTEM

5. Name of agent

~~Beresford & Co~~ Fitzpatricks

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Patents ADP number ~~1/82~~ 6001

6. Priority details

Country	Priority application number	Date of filing

Patents Form 1/77

7. If this application is divided or otherwise derived from an earlier UK application give details

Number of earlier of application | Date of filing

8. Is a statement of inventorship and or right to grant of a patent required in support of this request?

YES

9. Enter the number of sheets for any of the following items you are filing with this form.

0 Continuation sheets of this form

8 Description

0 Claim(s)

0 Abstract

NO

0 Drawing(s)

10. If you are also filing any of the following, state how many against each item.

0 Priority documents

0 Translations of priority documents

0 Statement of inventorship and right to grant of a patent *(Patents form 7/77)*

0 Request for preliminary examination and search *(Patents Form 9/77)*

0 Request for Substantive Examination *(Patents Form 10/77)*

11. I/We request the grant of a patent on the basis of this application

Signature BERESFORD & Co Date 30 July 1997

12. Name and daytime telephone number of person to contact in the United Kingdom

JOHN JAMES GRAY

Tel: 0171-831-2290

LOCAL COMMUNICATION SYSTEM

A local communication system which combines source data (CD audio, MPEG video, telephone audio etc) with control commands in a low cost fibre network is available in the form of D2B Optical. For details, see for example the "Conan Technology Brochure" and the "Conan IC Data Sheet" available from Communication & Control Electronics Limited, Stirling House, Stirling Road, The Surrey Research Park, Guildford, Surrey GU2 5RF (internet http://www.candc.co.uk). See also German patent applications of Becker GmbH with filing numbers 19503206.3 (95P03), 19503207.1 (95P04), 19503209.8 (95P05), 19503210.1 (95P06), 19503212.8 (95P07), 19503213.6 (95P08), 19503214.4 (95P09) and 19503215.2 (95P10). "Conan" is a registered trade mark of Communication & Control Electronics Limited.

In the basic D2B Optical system using the OCC8001 Conan IC, source data channels are provided at fixed data rates, synchronised with, for example, the CD audio sample rate. The present application describes techniques for achieving variable rate data transfer, referred to as asynchronous data handing, within a D2B Optical network.

In accordance with one aspect of the invention, a bit in each frame or subframe is employed as a validity flag, corresponding to a source data channel, so that the source data channel need not contain valid data all the time. A flow control bit may also be provided, for the destination station to indicate when its buffer is nearly full. In the ring network, the flow control bit and the validity bit can occupy the same position in each frame.

One embodiment based on D2B Optical uses a separate source data channel to carry the validity bit/flow control bit for one or more asynchronous data connections. In another embodiment, a "SuperConan" network is proposed, with similar asynchronous data handling provided within the frame strcture itself.

In connection with the flow control, a network such as the D2B Optical network has a latency in the source data depending on the nature and number of stations in the network. A mechanism can be provided for determining network latency automatically. The result is then used in predicting buffer overflow for an efficient control mechanism.

These embodiments will now be described in more detail with reference to the drawings incorporated herein.

1. Introduction

Asynchronous data is whose rate of delivery is not matched on a frame level with the transport provided by D2B Optical. This situation applies in the following cases:

1. where the source cannot provide continuous output
2. where the source output rate is not matched with the nearest available D2B Optical transport rate (calculated from: *bytes-per-frame* * *frame-rate*).
3. because of a variable rate of consumption in the receiver of the data

1.1 Range of Bit Rates

The following table shows the various methods for transporting data and the data rates which are possible with these. The system is assumed to be operating at a frame rate of 44.1 kHz.

Type of Transport	Type of Data	Bit-Rate Range	Extra Hardware
Control Message Channel	Non-Real Time	0 to ~8kbps	No
Transparent Message Channel (per channel)	Real/Non Real Time	0 to ~40kbps	Yes
Source Data (per frame byte)	Real/Non Real Time	0 to 352.8kbps	Yes

Key to Table: *bps* .... Bits per second.

1.1.1.1 Data Transport over the Control Message Channel

The control message is capable of supporting transport of non-real time data, using the Data Transport Protocols. The data to be transmitted is segmented into control message frames which are transmitted then reassembled in the receiver.

At a frame rate of 44.1 kHz, the data capacity of the control message channel is 44100*4*16*8/192 = 117600 bits/second. However, due to a minimum interval of 10 milliseconds between message transmissions, the useable rate would be ~11 kbits/second. To avoid the possibility of transmission failure (and thus retransmissions) the receiver of the data should be able to clear the Conan's (or SuperConan's) receiver buffer within T_{serve} = 10 milliseconds (cf the current requirement of T_{serve} = 25 milliseconds).

A further limitation of data rate arises from framing overheads (25%), leading to a transfer rate of up to ~8 kbits/sec.

1.1.1.1.1 Jitter in Delivery Times

Note that the control message channel is not suitable for transporting real-time data since it is an asynchronous channel where the time to deliver a frame of data varies with:

1. the arbitration time (time take to find a free control message frame), which depends on the current bus loading, this would be of the order of a few milliseconds.
2. the time taken for the receiver to receive the message, which depends on how quickly the receiver reads its Rx and the number of other devices which are currently transmitting messages to that same device. Whilst the receiver remains busy a single frame could be delayed up to approx. 350 milliseconds (beyond which no further attempt would be made to retransmit the frame.

1.2 Generic Mechanism

The following mechanism can be applied to Conan or SuperConan applications, where serial source data ports are used.

An Asynchronous datastream can be matched to the synchronous flow on D2B Optical by the insertion of null data (padding), provided that:

1. the rate of the asynchronous data is lower than the rate provided by D2B Optical (any peaks above this rate must be absorbed by buffering in the source device) and that
2. the receiver can detect and separate the required data from the padding.

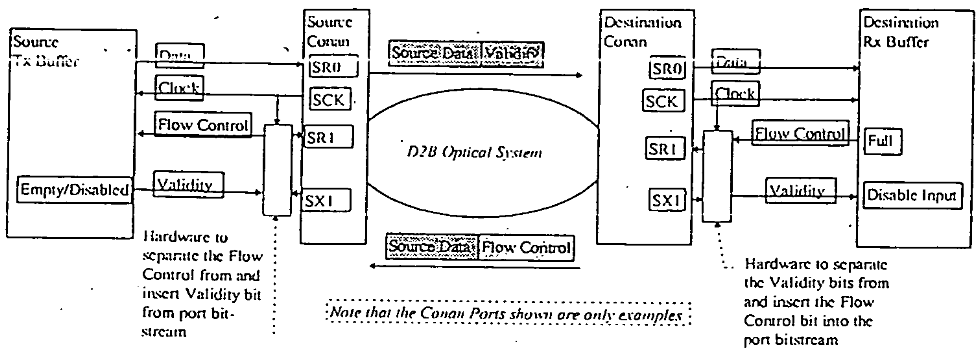
In this document two mechanisms are described for the insertion of padding:

1. Within the byte-stream of a source data connection, at sub-frame-level, where a flag (generated by the source) indicates whether the bytes for the specified connection in that sub-frame contain useful data or padding.
2. Within a packetised data stream, where packets can either be null (completely empty) or be partially filled. In this case the destination can use information in the packet header to separate the data from the padding.

1.2.1 Byte Stream Flow Control

This mechanism is relatively simple and can be implemented with simple hardware attached to the Conan at the source and at the destination.

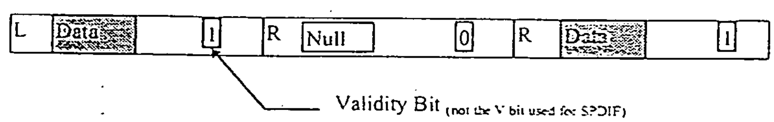
Asynchronous Data Transmission: Example



Each connection is allocated a number of source data channels within a subframe. At the same time as the connection is set up, a validity/flow-control bit is reserved within the a source data byte in one of the subframes. The bit is allocated for use only in conjunction with this connection and is used to signal Validity (from sender to receiver) or Receiver Buffer Full (from receiver to sender). Note that the same bit can be used for both functions (in different parts of the ring) because each ring segment is physically independent of the other segments.

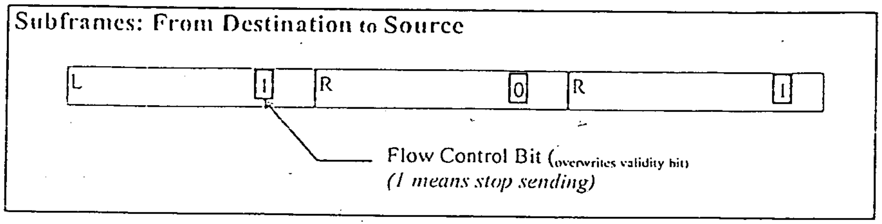
When the bit is set by the Source to '1' this indicates that the bytes allocated to the connection is this subframe are carrying valid data. '0' indicates that the bytes are not carrying valid data and may be ignored by the receiver (destination). Note that these bytes could be used for a non-real-time signal which can make use of this otherwise unused capacity. This other signal would need to be identified during connection set-up.

Subframes: From Source to Destination



When the bit is set to a '1' by the destination, it indicates that the destination's receiver buffer is now full. When the bit is set to a '0' it indicates that the

destination's receiver buffer now has space for at least the number of bytes which are delivered within 1 subframe (fixed when the connection is set-up).



1.2.1.1 Latency of Flow Control

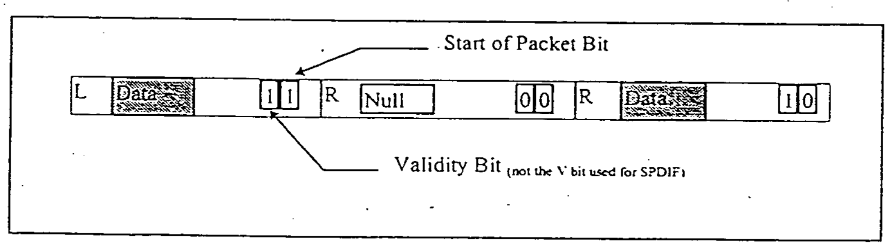
Allowance should be made for the number of frames which are already in the course of transmission around the ring. This means that the full indication may need to be replaced by e.g. a half full warning so that capacity remains for the bytes which are in transmission. The number of bytes in transmission depends on the number of bytes used per frame (for this connection) and on the number of devices with open source data bypasses between the source and the destination devices. To this must be added the delay in the source receiving the flow control flag, which depends on the number of devices with open source data bypasses between the destination and the source.

The total latency (in bytes): *L = (number of sources * 2) * number of bytes per frame, where the System Master is always counted as a source.*

This latency can be determined when the system starts up by placing a recogniseable marker in the source data field of the D2B Optical frame and observing the number of frames delay before it is received back by the sending device. This total frame delay can then be reported to all other devices via a control message.

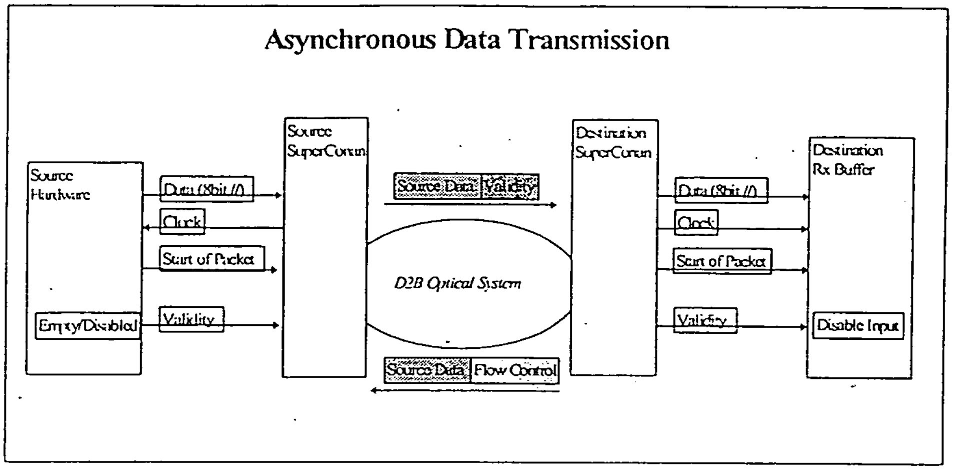
1.2.2 Packet Framing

In addition to the simple validity/ flow control mechanism described above, it is possible to use an extra bit in a subframe to indicate whether that subframe contains the start of a packet. If set to '1', then the subframe contains the start of a packet, in which case the packet will start with the first byte (of the allocated bytes) within that subframe). This bit is set by the sender of the data and read by the receiver. .



1.3 SuperConan: Packet Transfer

SuperConan supports packet transfer over the network. The data source must supply data to the sending SuperConan via the parallel port and must indicate the start of each packet via a pin (Pkt_In). The destination can retrieve the packets from the receiving SuperConan via its parallel port with the start of packet being indicated via the Pkt_Out pin.



In the SuperConan the Validity and Start of Packet bits are allocated 1 bit in alternate subframes, following the VUC (S/PDIF) bits, as shown below.

1. The validity flag (Vd) is set to '1' when the source data for the asynchronous connection (contained in that frame) is valid. When the validity flag is set to '0', the data is not valid.

2. The Start of Packet (Sp) is set to '1' when the start of a new packet for the asynchronous connection (contained in that frame) has occured in the left subframe. When the validity flag is set to '0', the data is a continuation of an existing packet.

Left Subframe

Pre	Source data bytes	V	U	C	Vd	SB	CF0	CF1	P

Key:
Pre: Preamble
Vd: Data valid indicator
Sp: Start of Packet

Right Subframe

Pre	Source data bytes	V	U	C	Sp	SB	CF0	CF1	P

1.4 Packet-Level Flow Control

At the packet level the rate of data delivery can be regulated by inserting null or partly filled packets. These data flow reduction mechanisms can be used either where the

source has insufficient data to supply (empty Tx buffer) or where the receiver has notified the source that its buffer is (nearly) full and thus no more data can be accepted. When the receiver buffer is (nearly) full, the receiver can signal this either via a dedicated flow control bit such as that described (Byte Stream Flow Control) above or via the Connection Signalling message